

SAFE PRACTICES

NATIONAL SAFETY COUNCIL

168 NORTH MICHIGAN AVENUE, CHICAGO

*Being an orderly presentation in loose-leaf form of accident hazards
and the best practices for their elimination.*

PRICE TWENTY-FIVE CENTS

NUMBER 43

PASSENGER ELEVATORS

1. In a large city with high office, store, and factory buildings, the number of passengers carried by elevators—counting each trip separately—is greater than that carried on street cars. Most office workers, a large percentage of factory and retail store workers, and practically all customers in any of these establishments use the elevators. While the elevator accidents are very few, in proportion to the number of passengers, still the great number of passengers carried, and the fact that a large percentage of elevator accidents result in death or permanent injury make it desirable to adopt all practicable safeguards.

2. The Elevator Safety Code of the American Society of Mechanical Engineers, prepared by a committee of that society in conference with a large number of other interested parties, is recognized as the best standard on this subject. The purpose of the present pamphlet is not to duplicate the A. S. M. E. code but simply to set forth the most important points in the safe equipment and operation of passenger elevators in a form as useful as possible to the members of the National Safety Council. The suggestions in this pamphlet are in line with the requirements of the A. S. M. E. code, to which in some cases reference should be made for detailed information.

3. This pamphlet is limited to hydraulic and electric power passenger elevators. Freight elevators have been covered in an earlier pamphlet (No. 15).

4. The electric elevator, developed later than the belt-driven and hydraulic types, has a number of advantages both in safety and in facility of operation but has also introduced some special hazards. The most recent advance in elevator design was the development of the traction type which, although it involves

some problems of its own, possesses the decided advantage (from the safety standpoint) that the power which can be transmitted from the motor to the elevator car is limited to the amount which can be transmitted by means of the friction between the cables and the driving sheaves. This means that with proper arrangement of bumpers for the car and counterweight it is unlikely (except in the case of very high rise elevators) that either the counterweight or the car can be drawn into the overhead machinery even if the motor fails to stop. (Fig. 1.)

HOISTWAYS

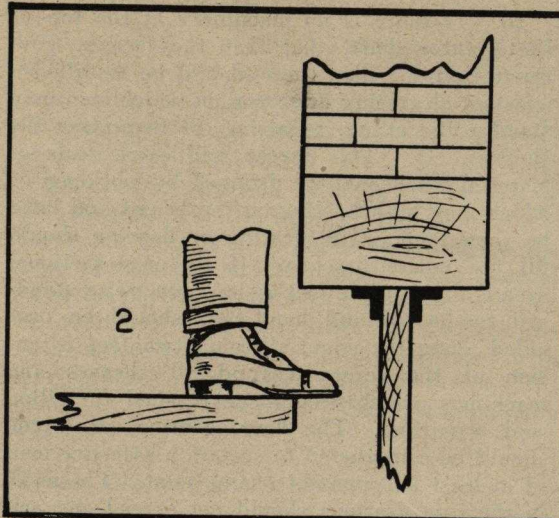
5. Experience has demonstrated the value of the elevator as a life-saving device in case of fire. A simple form of fire-resisting construction will usually keep the fire from the hoistway for a greater length of time than the elevator need be used as an exit from a burning building. Such enclosures also prevent the rapid spread of fire from floor to floor. Fire-resisting hoistway enclosures are therefore recommended for all elevators. The building code of the National Board of Fire Underwriters should be carried out fully unless state laws or municipal ordinances provide more stringent requirements.

6. There should be a clearance of not less than three-quarters of an inch nor more than one and one-half inches between the car platform and the threshold of any landing. The clearance between a hoistway wall or enclosure and an open side of the car platform should not exceed four inches.

7. The surfaces of all hoistway walls facing car openings should be smooth and free from protruding objects. Where projections such as floors or beams are unavoidable a substantial bevel guard is necessary to decrease the danger of toes being crushed between the projection

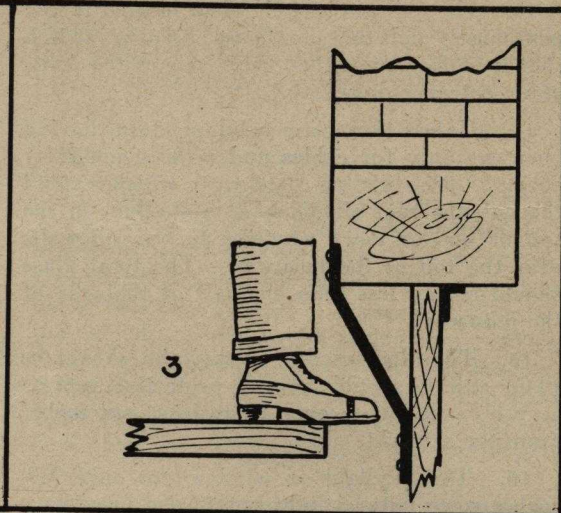
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Courtesy, Aetna Life Insurance Co.
FIG. 2. PROJECTION IN HOISTWAY

This condition is dangerous, particularly on the landing side of the elevator car, where a person may be standing preparatory to alighting at the landing above.



Courtesy, Aetna Life Insurance Co.
FIG. 3. BEVEL ANGLE BAR ON PROJECTION

As the elevator car rises the angle bar gradually forces back the protruding foot. Elevator car gates, fully closed when the elevator is running, serve as another guard against the injuring of toes.

and the car platform. To be effective, this toe-guard must be of substantial construction (preferably metal or smooth concrete) so it will not bend, and must form an angle of at least 60 degrees, 75 degrees if possible, with the horizontal so it will push the foot back and not crush it. The guard should extend back to the vertical wall (Figs. 2 and 3). The maximum amount of safety from projections and indentations in the hatchway, can be obtained by the use of a car gate (see paragraph 68).

8. Where there are two or more elevators in adjacent hoistways the clearance between adjacent cars should not be less than two inches. A partition between two elevators, provided each elevator car is closed, is not necessary except that there should be partitions in the pit to protect men working in the pit while an adjacent elevator is in use.

9. Outside windows, below the seventh floor, on elevator hoistways should be barred or grated to prevent firemen from breaking through, with the possibility of falling down the shaftway or at least of increasing the draft for the fire. By having hoisting windows barred, time is saved the firemen in setting and climbing ladders only to find that there is an elevator hoistway. The presence of the grating on the outside of the windows is required by some cities as a notice to the firemen. It is also customary in some cities to put up signs at these windows, on the outside, to indicate the presence of an elevator shaft inside.

10. The overhead beams in the hoistway should be placed high enough so that the car can travel at least two and one-half to seven feet, according to the specified speed of the elevator, above the highest landing. Above the beams there should be sufficient head room for the safety and convenience of men inspecting or repairing the machinery or sheaves. See also the following section.

¹Penthouses

11. Penthouses are installed at the top of elevators to provide safe and convenient access to the machinery at the top of the elevator hoistway. There should be plenty of light available, both natural light and artificial light. The convenience of those making repairs on elevator machinery should be considered further by making the height of the penthouses at least six feet, if possible. It should not be necessary for workmen to have to get on top of the elevator car and ride up on the top of the car in order to get into the penthouse. A separate stairway, with standard rail, should lead from the roof or from inside of the building to the penthouse.

12. If the penthouse door opens out, a platform should be provided not less than two feet wide, and located not more than eight inches below the door sill of the penthouse.

¹Paragraphs 11 to 24 apply also to the working space above beams in cases where the top story is high enough so that no penthouse is required.

13. The elevator switch when located in the penthouse, and the penthouse lighting switch should be located at the "lock" side of the penthouse entrance door.

14. Unless there is a solid platform having openings only for cables under the machine or sheaves, fire-resisting hoistways which extend through the roof should have a skylight in the top or one or more windows in the sidewalls near the top of the hoistway. The total glass should be not less than one-half of the area of the hoistway.

15. The glass used as a skylight, should be plain and it should have a protective netting securely supported over it at least six inches from the skylight.

16. The skylight or window not only furnishes some natural light but it also provides a vent for smoke and hot gases in case of fire. Better ventilation for the hoistway is secured, and arrangements should be made so that the ventilation may be easily adjustable.

18. No material should be stored in the penthouse.

19. If the elevator machine is located in the penthouse, a substantial floor, of mill or fire-proof construction (depending on the construction of the building) should be provided under the machine and it should contain no openings except for the cables, when the clearance should be not more than one inch. Toe-boards should be placed around such openings. Such a floor will greatly facilitate the oiling, repairing, or replacing of the machinery. The grating or flooring should fill the entire hatchway if its cross-sectional area is 50 square feet or less, otherwise there should be a substantial railing and toe-boards around the edge of the floor.

20. If there is no machinery at the top of the elevator shaft other than the sheaves, governor, and the like, there should be installed a substantial grating or screen on which men may stand while oiling, repairing, or inspecting the sheaves, etc. This screen will catch tools or material which may be dropped by workmen or which may be left lying on the beams and later be jarred off. The grating or flooring should fill the entire hatchway if its cross-sectional area is fifty square feet or less, otherwise standard toe-boards and hand-rails should be provided along the edge, allowing two feet extension of the screen beyond all sheaves and machinery which need to be reached for oiling and repairing. The floor, grating, or screen should be constructed to sustain a safe live load of at least 300 pounds at any point. The mesh in the iron gratings should not exceed one and one-half inches.

21. Any grating such as mentioned in paragraph 20, with mesh larger than one and one-half inches, should be covered with an additional screen of smaller mesh. This will prevent nuts, bolts, etc., from falling through.

22. In the case of traction elevators there should be another screen below the secondary sheaves for protection against falling tools, etc.

23. No elevator machinery (except the idler or deflecting sheaves, the governor, and other safety devices) should be hung underneath the supporting beams at the top of the shaft-way.

24. For winding drum machines provisions should be made to see that a substantial beam or bar is placed at the top of the counterweight guide rails and beneath the counterweight sheaves to prevent the counterweight from being drawn into the sheaves.

OVERTRAVEL AND CLEARANCE FOR POWER ELEVATORS						
	Speed ft. per min.		Over-travel at top, ft.	Clearance at the top, ft.	Over-travel at bottom, ft.	Clearance at bottom ft.
	Above	Up to and including				
Hydraulic Plunger Elevators	0	50	2½	2	1	2
	50	150	3	2	1½	2
	150	300	5	2	2½	2
	300	500	7	2	3½	2
Other types of Power Elevators	0	150	3	2	1½	2
	150	350	4	2	2½	2
	350	500	5	2	3½	2
	500	600	5½	2	4½	2
	600	800	6	2	5½	2

Pits, Overtravel, and Clearances

25. The floor of the pit should be approximately level, with sufficient pitch for drainage.

26. Ample illumination should be provided for elevator pits as well as for all other parts of the installation.

27. As to clearance between the bottom of the elevator and the floor of the elevator pit there are various allowances according to the type of elevator and the speed. The general variation is from one to five and one-half feet of overtravel from the lowest landing to the point where bumpers are fully compressed with a clearance of two feet additional from this point to the pit-bottom. See accompanying chart.

Unsafe Use of Pits and Hoistways

28. The pit should never be used as a thoroughfare and nothing should be placed in the pit that will necessitate men working there. No part of the elevator machinery should be placed in the pit, excepting the bumpers and sheaves, nor should any material be stored there. No rope, wires, or pipe should be placed in the pit or in any part of the hoistway except such as are necessary for the operation of the elevator, and excepting branch sprinkler pipes and heads. If such ropes, wires, or pipes are placed in the shaft-way, men will occasionally have to work on them, and in spite of all precautions such men are likely to be injured. There should be a drain connection in the pit.

29. All electrical conductors installed in elevator or counterweight hoistways should be in metal conduits or armored cable with exception of the flexible cables connecting the car with the fixed wiring. All the metal-inclosing covering of the electrical apparatus should be thoroughly grounded, preferably to water pipes, and never to gas pipes. No pipes except those used to furnish or control power for the elevator or hoistway should be installed in the hoistway. Care should be taken to see that there are no connections, openings, tunnels, or outlets within the hoistway that have nothing to do with the operation of the elevator.

30. No part of any electric circuit whose voltage rating exceeds 750 volts should be permitted in any elevator hoistway, or should be permitted to be connected to any control switch or signal system. Circuits of higher voltage may be used in machine rooms or penthouses if these machine rooms or penthouses are separate from the hoistway and if all control and signal wiring is insulated from the power circuit, and all machine frames and metal hand ropes are thoroughly grounded.

31. If it is necessary to install high voltage circuits in the machine room the whole installation should be confined to one portion, with a notice prominently posted "Danger—High Voltage."

Hoistway Guards and Screens

32. Where a fire-proof enclosure is not provided, the hoistways should be enclosed to a height of not less than seven feet from each floor on all but landing sides. Where an elevator is located adjacent to a stairway that portion of the hoistway adjoining the stairway should be enclosed to a height of not less than seven feet above each stair tread. The hoistways of passenger elevators should be enclosed from the floor to the ceiling on the landing sides.

33. The hoistway enclosure on the side where the landing doors are should be of sufficient strength to hold in true alignment the landing doors with their operating mechanism and interlocks. Fig. 4 shows a firm hoistway enclosure with a fine wire mesh to prevent persons putting their hands through the grill openings.

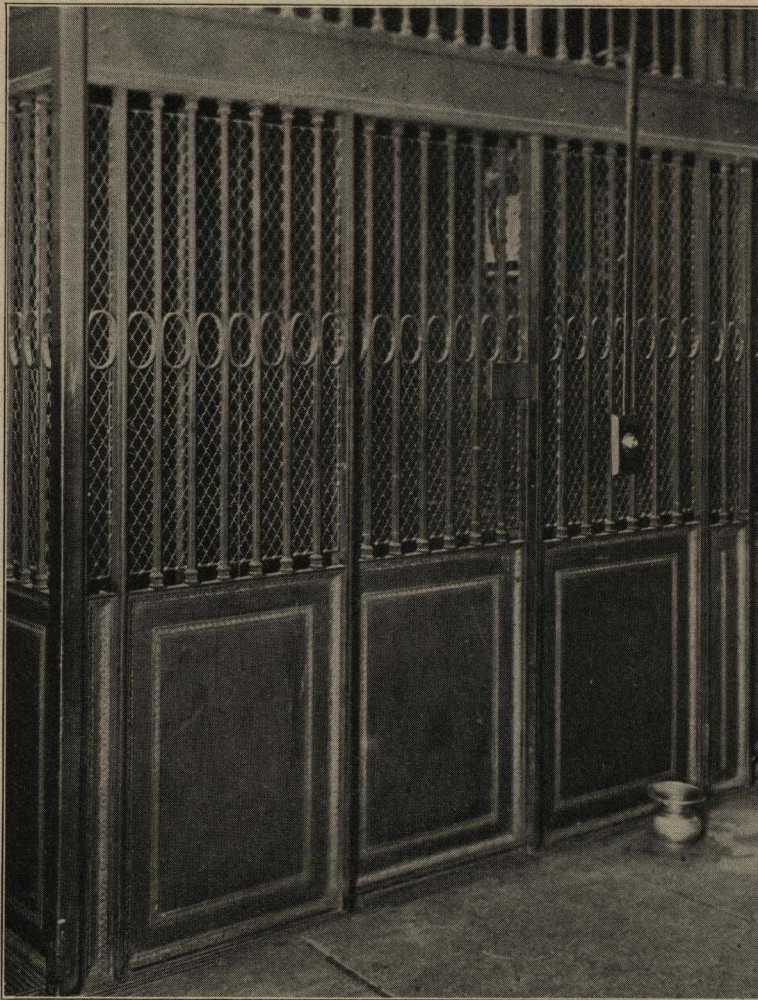
Thoroughfares

34. In case there is a thoroughfare under a hoistway it is necessary in addition to the bumpers and other safety devices that there be a floor under the hoistway sufficiently strong to withstand, without injury, the impact of the car of counterweight descending with rated load and at normal speed.

Counterweight Runway Enclosures

35. Counterweight runway enclosures located in the hoistway should be enclosed from a point twelve inches to a point at least seven feet above the floor of the pit. This protects men working in the pit and at the same time leaves a space for cleaning out. Counterweight runway enclosures should, however, be prohibited where compensating chains are used as the chains are liable to become entangled in the runway enclosure, and may tear the enclosure from its fastenings with the subsequent hazard involved. Where the counterweight runways are outside of the hoistway they should be enclosed the full length, or if located outside of the buildings they should be enclosed to a height of at least seven feet above the ground.

36. Provision should be made, in all cases, for access to do proper inspecting and repairing of cables and counterweights. If doors are provided for counterweight enclosures they should be equipped with spring hinges so that they cannot be left open.



Courtesy, Aetna Life Insurance Co.

FIG. 4. HOISTWAY GRILL WORK WITH ADDITIONAL FINE WIRE MESH

A hoistway enclosure with solid metal sides, three or four feet high surmounted by open grill work makes a strong enclosure. The use of fine wire mesh on the grill work, beyond a height reached by hand, guards against injuries to persons who might otherwise put their hands through the enclosure.

37. Where cables pass through floors outside the hoistway they should be guarded to a height of at least six feet.

38. Gate or door counterweights should be boxed in to prevent their becoming dislodged and hitting any one or any one getting in line with the moving counterweights. The bottoms of the boxes should be strong enough to hold the counterweights in case the counterweight rope should break.

LANDINGS

39. State and city requirements vary some as to the type of doors to be used at the elevator landing. In general horizontal sliding doors, with interlocking devices, are the rule. The use of swinging doors is not advisable.

Landing doors should be equipped with a self-action lock which requires a key or special mechanism to open it from the landing side. The key or special mechanism to these landing doors should be kept by a responsible person.

40. No automatic fire door, the functioning of which is dependent upon the action of heat should be used to close any landing opening in the hoistway of any passenger elevator nor any exit leading from any hoistway landing door to the outside of the building.

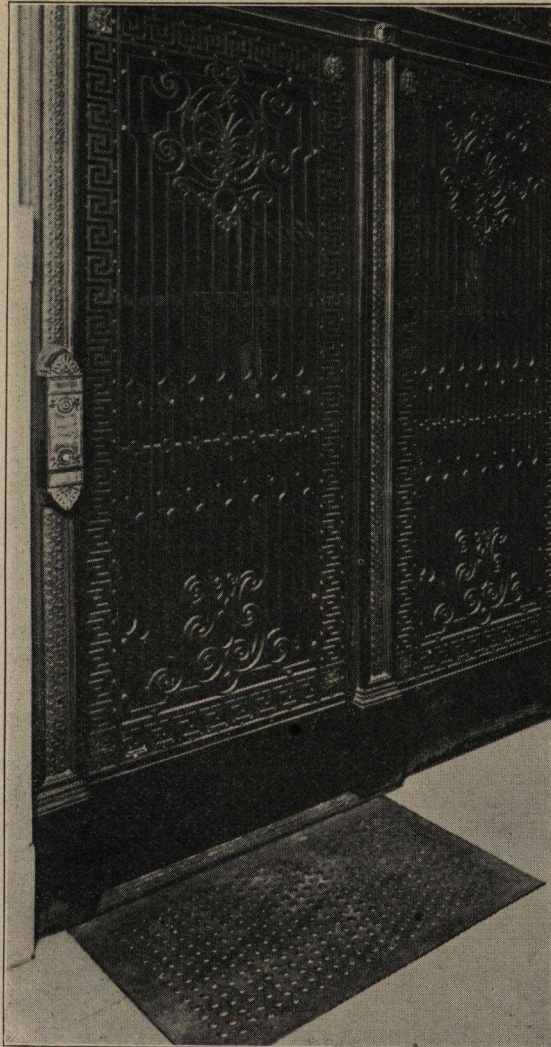
41. The landing platform, for a distance of at least two feet back from in front of the door, should not have any exposed metal or slippery material upon which one is liable to stand. It is much better to use rubber mats, firmly secured, or some anti-slip material, directly in front of all landing doors of the hoistway. (Fig. 5.)

42. Adequate lighting should be provided both in the elevator and at landing platforms. Fig. 6 shows one method of lighting the landing edge of the car floor to help prevent tripping.

43. In cases where two sliding doors come together to close a landing rubber cushions may be put on the frame of the doors to prevent injuring the operator's fingers. (Fig. 7.)

44. To insure the positive closing of the landing hoistway doors for passenger elevators there are a number of devices on the market which prevent the elevator from moving up or down until the landing door is closed. The two types are (a) purely mechanical, (b) electrical mechanical. The use of these interlocks is required by some states.

45. All interlocking devices should be of a type which cannot easily be plugged or made inoperative in any way, except by use of the emergency release.



Courtesy, Aetna Life Insurance Co.

FIG. 5. RUBBER MAT INSERTED AT A LANDING

A firm door mat, not too heavy, gives a good foot hold in front of an elevator landing door.

Interlocks and Electric Contacts

46. The A. S. M. E. Elevator Code classifies these devices as (a) interlocks and (b) electric contacts.

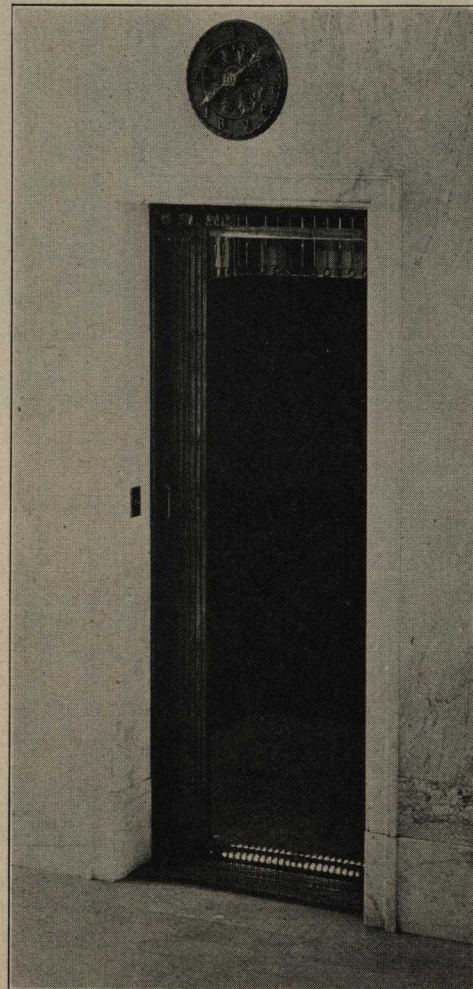
47. The interlock is a device which, in addition to preventing movement of the car when the landing door is unlocked also prevents the opening of the landing door from the landing side unless the car is at the landing. Some types require only that the landing door opposite which the car is standing, be closed and locked; others require that all landing doors be closed and locked before the car can be moved.

48. Electric contact devices perform only one of the two functions of the interlock—that

is, they prevent the movement of the car unless the landing door (or all doors) is closed. In the case of electric contacts the landing door is considered as being closed when it is within two inches of the fully-closed position.

49. In the case of interlocks the landing door is considered as being locked if it cannot be opened from the landing side more than four inches.

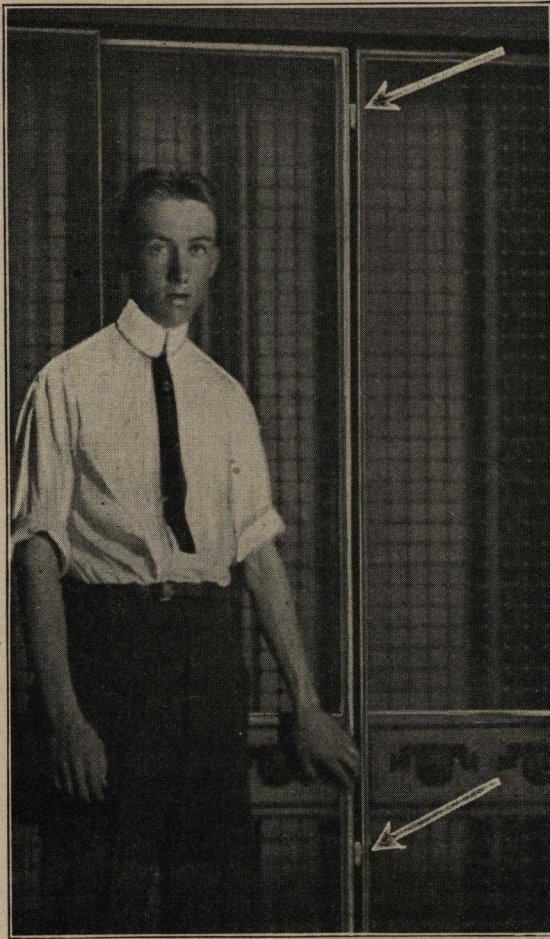
50. Every interlock or electric contact should be provided with an emergency release device which will permit the operation of the car regardless of the position of the doors, in case of fire or other emergencies. This release should be plainly visible to the occupants of the car, and accessible, but not easily so, to the



Courtesy, Aetna Life Insurance Co.

FIG. 6. GOOD LIGHTING AT THE THRESHOLD OF AN ELEVATOR CAR

This threshold light, showing when passengers are getting on or off the car, helps to eliminate the tripping hazard. It is in the flooring and protected by open metal work.



Courtesy, United Gas Improvement Co.

FIG. 7. SAFETY RUBBER STOPS ON ELEVATOR DOORS

Though apparently of minor consideration, the use of safety rubber stops on elevator doors prevents injuries to the car operator's hands. Landing doors are closed many times in a day, and the stops give finger clearance between door frames.

operator. This device should never be used except under extraordinary conditions. The emergency release should be placed in a box with a glass front which can be easily broken when necessary. If used, an explanation should be forthcoming, and a new piece of glass should be immediately placed on the front.

51. The interlock or electric contacts should not prevent the movement of the car when the emergency release is in temporary use or when the car is being moved by a car-leveling device.

52. Figure 8 shows the chances for accidents where passenger elevators are not equipped with interlocks or electric contacts. A person may receive serious injuries through opening hoisting doors, at will, from the landing side, and subsequently being struck by a moving car.

53. Like any other safety device, an elevator interlock or electric contact is likely to be worse

than useless if it is of a type which easily gets out of order. It is advisable therefore to use only those devices which are approved by Underwriters' Laboratories, or by other laboratories that have proper equipment and personnel to pass on the merits of devices. It is also very necessary to watch the device after it is installed and see that it is always in good order and that the operator or attendant does not meddle with the electrical or mechanical parts and thus put the device out of commission.

54. All interlocks tend to slow down the service more or less, hence the temptation to evade their use by owners and operators. The obvious remedy is to choose a type that while dependable, slows down the service least.

55. Landing doors closed by hand should be arranged so that it is not necessary to reach back of any panel, jamb, or sash to operate them.

56. It is important to provide sufficient light at the floor level of each landing. The A. S. M. E. standard is three-fourths that given by a standard candle one foot distant.

Car Leveling Device

57. This device automatically brings the elevator platform level with the desired landing, and maintains this landing during loading and unloading independently of the stretch of the hoistway cables. Tripping hazards are eliminated, as well as the necessity of the operator making several attempts to bring the car level with the landing, which adds greatly to the wear and tear on the mechanism.

MACHINE ROOMS FOR ELEVATORS

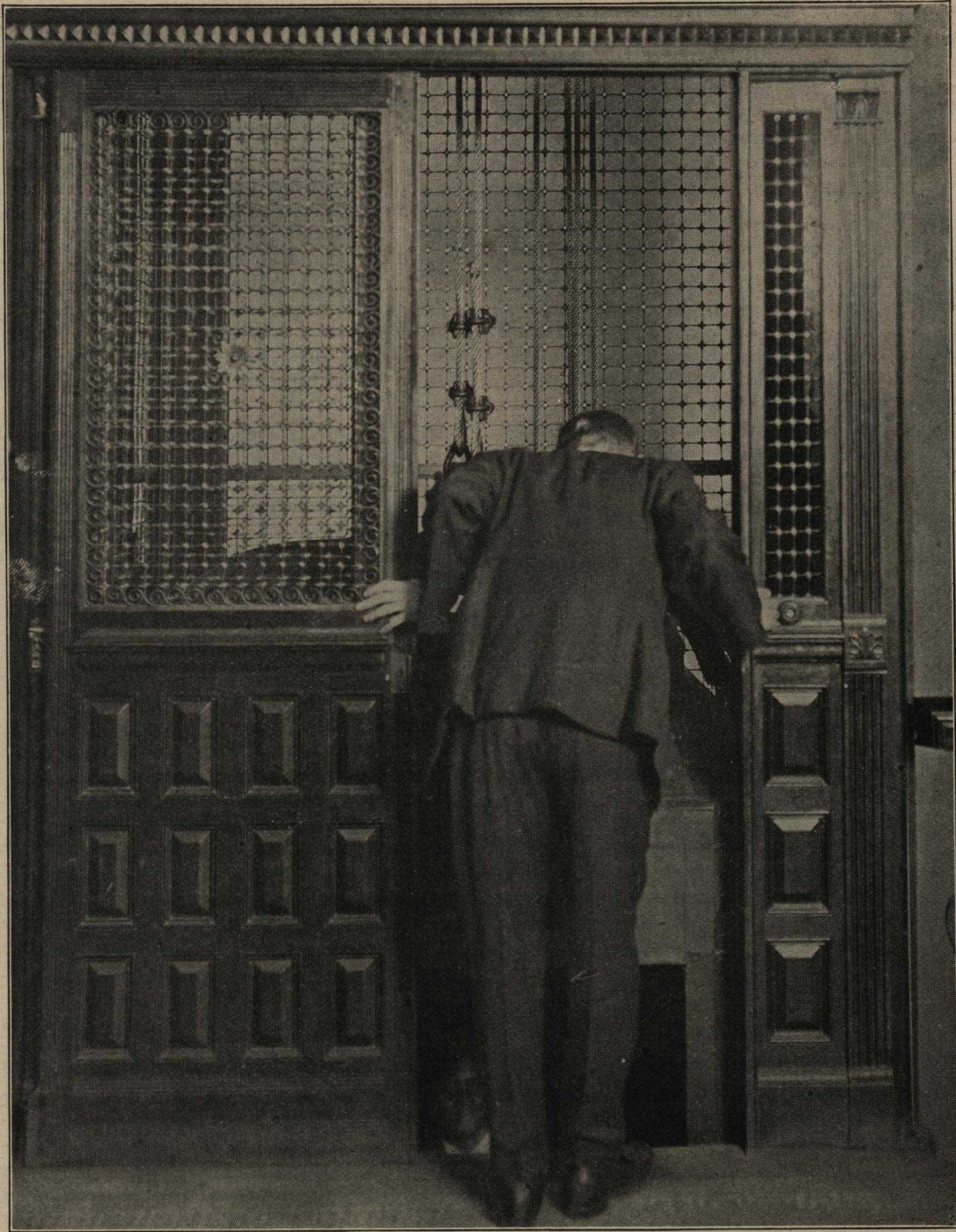
58. Unless the elevator machines are in a separate room in charge of an attendant they should be surrounded by substantial grill work or some other form of enclosure to keep persons away from them. Care should be taken to see that exposed gearing, belts, and other moving parts of the elevator machinery are properly guarded.

59. The elevator machinery should not be located in the hoistway. This gives the repairman safe and convenient access to the machinery. Proper lighting is very necessary around the elevator machines.

CAR CONSTRUCTION AND SAFETIES

60. No material not a permanent part of the elevator equipment should be permitted on the top or cover of the elevator car.

61. All passenger elevator cars should be enclosed on all sides not used for entrances and on the top.



Courtesy, Labor Department, State of New Jersey

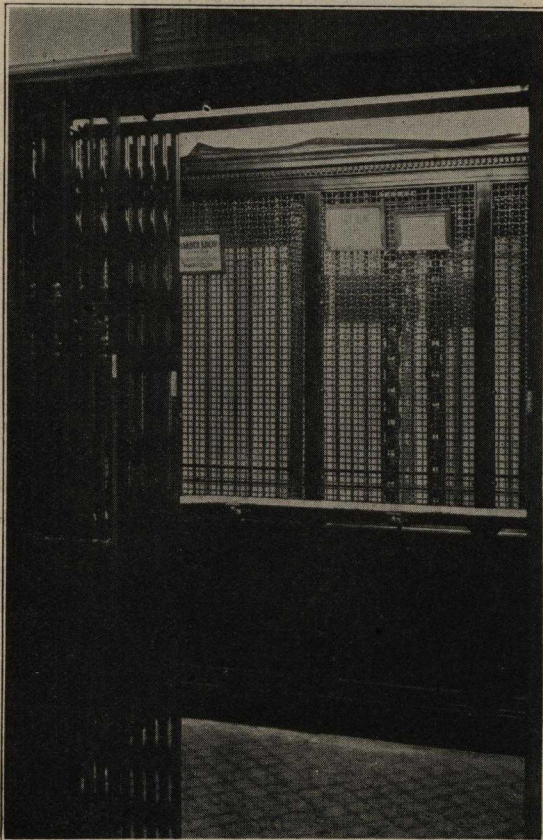
FIG. 8. INTERLOCKS ARE NEEDED ON HOISTWAY DOORS

A hazardous condition exists where a person can open a landing door while the car is running up or down in the hoistway. Door interlocks prevent the movement of the elevator car unless all hoistway doors are closed and locked (Hoistway Unit System) and prevent the opening of a hoistway door from the landing side unless the car is standing at rest at the landing.

62. The enclosures may be made of metal or wood, solid or open work. The car sides, to a height of six feet from the car floor, should contain no openings larger than one-half inch; above that open work design may be used, the opening of which will not pass a ball two inches in diameter. (Fig. 9.) The car enclosure should be firmly secured to the car floor in such a manner that it cannot work loose or become displaced in ordinary service.

63. No cast iron should be used in tension as a suspension member of the frame of any car.

64. The use of mirrors in elevators is dangerous as they are likely to confuse the passengers and are also a source of danger through breakage in cases of the dropping of the elevator car; the sudden application of safeties, or the car striking bumpers. Many recent state laws prohibit the use of glass in elevators with the exception of using it for covering certificates



Courtesy, Aetna Life Insurance Co.

FIG. 9. GRILL WORK ON CAR AND COLLAPSIBLE CAR GATE

Both of these safety features should be on every passenger elevator car. The grill work prevents persons extending their hands through the car enclosure. The collapsible car gate, stretched across the car entrance when the car is moving, keeps the passengers within the limits of the car floor.

and applications necessary for the operation of the car.

65. Ample light should be provided in the car at all times.

66. There should be but one compartment for each elevator car. If there were more than one compartment car the operator could not see what was going on in the other compartment.

67. It is not considered advisable for passenger elevator cars to have more than two entrances; not counting emergency exits. Emergency exits should be located at the top of the car. If there are two or more elevators in adjacent hoistways, and the vertical distance between any two consecutive landing openings exceeds thirty feet there should be provided, in addition to the top exit, an emergency side exit to the adjacent car.

68. Every elevator car should be equipped with a gate for each car opening. The gates should be shut when the car is running. Some states have laws which require the use of contact devices to insure the complete closing of the car gates before the car can be operated. In all cases the gate when closed should guard the full opening.

69. In some concerns elevators are used for combination freight and passenger service, such as passenger service during the change of shifts and freight service during the rest of the day. In such cases, if a gate on the car is not practicable, it is suggested that a row of large headed nails be driven across the elevator floor about two feet back from the landing edge, and that the operators of the elevators be given positive instructions not to move the cars should any one approach forward over the line.

70. Passenger elevator cars should not be arranged to counterbalance one another. The same reason applies here as in paragraph 66.

71. State and city laws provide that all elevators except the direct plunger type shall have speed governors. This speed governor operates the device clamping the car to the guides when the car attains excessive speed in its descent caused by the breaking of the cables or other derangement of elevator equipment.

72. The minimum diameter of the governor cable should be not less than $\frac{3}{8}$ of an inch. All governors to operate car safety devices should be set to trip at not more than 40 per cent above normal car speed, except that when speed exceeds 550 feet per minute this percentage should not exceed 30 per cent. The gripping portions of any safety device should not be used to guide the car. The type of safety device should be such that when applied any further motion in the same direction will not release the

gripping devices in the event of the adjustment being faulty; and in the event of tension on the governor being released, the gripping devices will remain engaged. The speed governor should be plainly marked with the rate of speed at which it is set to trip.

73. Traction elevators require a governor switch to stop the car when the safety is tripped and this is even more satisfactory if it stops the car in case of runaways before car safety trips, say at 20 per cent excess speed.

74. Before placing a new or repaired passenger elevator in service tests should be made to determine whether the car attains the rated capacity. At the same time the "safety" and speed governor shall be tested. In addition there should be periodic tests of all passenger elevators.

75. These tests should be made by an experienced elevator constructor or inspector.

76. The first test is made by loading the elevator to rated capacity and running it up and down at various speeds, observing whether the acceleration and braking are satisfactory, whether the motor operates smoothly, and whether the limit stops (see paragraph 99) bring the car to rest easily and at a safe distance from the overhead bumpers or lower bumpers.

77. The "safety" and speed governor are tested by causing the car to descend at a speed necessary for the governor to trip and actuate the "safety."

78. Excessive speed may be attained by changing the current in the field of the motor; such operations being done only by the elevator constructor or other properly qualified persons. The governor and "safety" should operate to stop the car smoothly and without damage to the passengers, car, or guide rails.

79. Where it is not practicable to overspeed the motor, a drop test should be conducted to determine the efficiency of the governor and safety device, in lieu of the overspeed test. This is performed by raising the car with capacity load aboard, to a height in the hatchway sufficient to allow for a free fall. The car is then hung with a cable from the crosshead of the car to the overhead beams, the hoisting cables disconnected and the cable holding the car to the overhead beams cut, permitting the car and load to fall free. This should be done by an experienced elevator constructor.

80. There should be posted in every elevator, in a conspicuous place, a metal plate showing the following:

- a. The capacity of the elevator in pounds.
- b. The maximum number of persons to be carried based on 150 pounds per person.
- c. The rated speed at which the elevator is designed to operate.
- d. Cable data as to size, number, kind, and strength.
- e. Weight of car.

81. Passenger elevator cars which are used for carrying safes or other heavy loads should be provided with "locking bars" which will hold the car at any landing independently of hoisting cables while the safe or other object is being loaded or unloaded.

COUNTERWEIGHTS

82. Counterweights should necessarily run in grooves.

83. If two counterweights run in the same guides, the car counterweight should be located above the machine counterweights with a minimum distance of eight inches between them, so that in case of failure of the machine counterweight cables the entire load of both counterweights will not pull on the car counterweight cables. This would result in pulling the car, if nearly empty, into the overhead works. It is better to run the two counterweights in separate guides.

84. In case independent car counterweights are used, the counterweight should not be of sufficient weight to cause any slack in any cables under the condition of an unloaded car during acceleration or deceleration.

85. All counterweights should be held together by tie rods having lock nuts and cotter pins. These rods should pass directly through all the weight sections. It is further advisable to hold the counterweights in a frame.

CAR AND COUNTERWEIGHT BUMPERS AND GUIDES

86. Spring type bumpers or their equivalent are necessary on all passenger elevators. These bumpers should be able to stop the car at a rate of not more than 64.4 feet per second. At this rate the pressure on a person's ankles is three times the normal pressure of the person's weight. Bumpers of spring type or equivalents should be put under all counterweights. Spring bumpers should be supplied up to the speed limit of two hundred and fifty feet per minute. For greater speed, oil bumpers or their equivalent should be used. In designing plunger elevators provision should be made to stop the plungers as well as the car. On other types of

elevators care should be taken to locate the bumpers or buffers symmetrically with reference to the center of the car sling.

87. All power passenger elevators should have steel guide rails for both the car and the counterweight. These guide rails must be firmly fastened with iron or steel brackets, to the hoistway to stand any stress or strain which may occur in the operation of the elevator either under normal conditions or when the safety stop may have to come into operation. Neither the guide rails nor brackets, under normal operation, should deflect more than one-fourth of an inch. The guide rail surfaces of the car and counterweight must be smooth, and be kept well lubricated. At the joints care should be taken to have an accurate fit.

MACHINES AND MACHINERY

88. All hoisting drums and sheaves should be of cast iron or steel, designed with 10 for the factor of safety, and should have machine-cut grooves not more than one-sixteenth inch larger than the ropes or cables. The factor of safety is based on the minimum carrying capacity of seventy-five pounds per square foot plus the weight of the car, cable, and counterweight.

89. Where sheaves are set on shafts they should be keyed on or if the sheaves run loose they should have proper bearings with provision made for lubrication.

90. Set screw fastenings should not be used in place of key-fastenings.

91. The use of friction gearing or a clutch mechanism should not be allowed for connecting the winding drums or traction sheaves to the main driving gear.

92. All machines should have, necessarily, brakes applied automatically by gravity or springs, when the control is at the "stop" position, and released, electrically, in the case of electrical machines by throwing the control mechanism into a starting position. The brake shoes should be independent in action, either shoe being capable of stopping the car.

93. Needless to say, proper guards should be provided on all elevator machines in accordance with the safety regulations governing machinery in general.

Hydraulic Elevators

94. The piston-travel-limit bumpers or stops should be of sufficient strength to withstand the full water pressure against the piston and the cable connections should be so arranged that the car cannot be drawn into the overhead beams.

95. Space does not permit a complete discus-

sion of piston rods, valves, pressure tanks, etc., but the A. S. M. E. code, and state and city laws may be referred to for data regarding automatic stop valves, water safety valves for pumps connected with the pressure tank, the size of the supply and discharge pipes, pressure gages for pressure tanks, etc.

96. When a hydraulic elevator creeps it indicates that packing of the valves or piston is not in proper order. The trouble should be corrected at once.

Machine Safety Devices and Terminal Stops

97. Automatic stops at the top and bottom of the hoistways are essential. There are various devices in use.

98. Hydraulic elevators should have, naturally, an independent automatic means for gradually stopping the car at the upper and lower terminal landings, independent of the operator. Where the speed of the elevator does not exceed 150 feet per minute the means employed may operate in combination with the car control mechanism, and the main operating valve. If the speed of the elevator exceeds 150 feet per minute, an automatic stop valve should be provided for this purpose. This valve should be independent of the main operating valve, and preferably in the piping between the main operating valve and the cylinder.

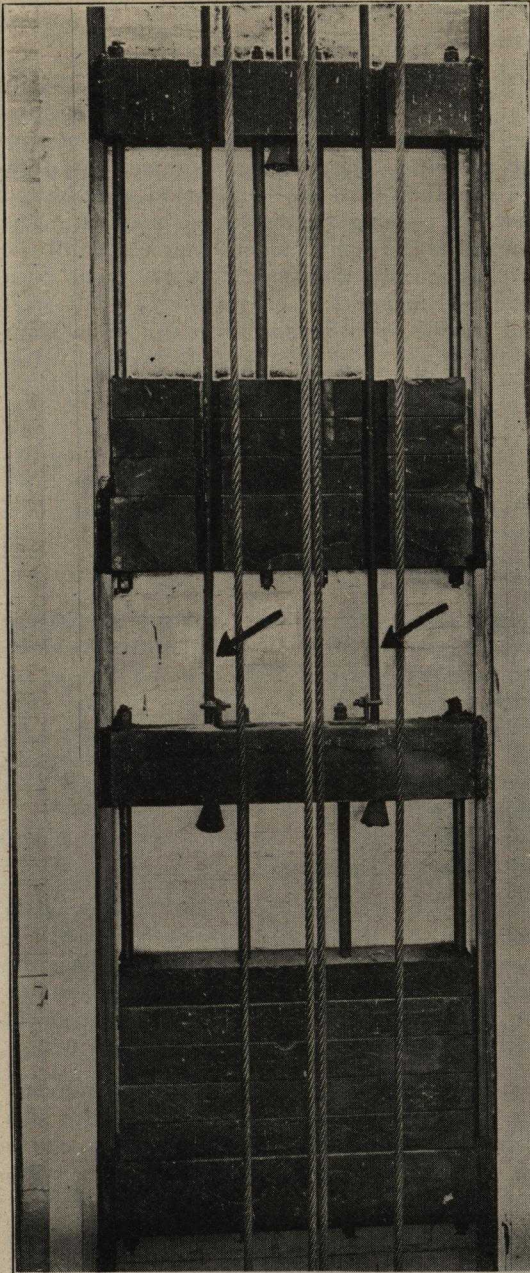
99. The automatic stops should be set to open the circuit or otherwise act before the car or counterweight exceeds its overtravel in the shaft, even when the starting lever in the car is in running position.

100. Some operators have the bad practice of making the automatic stop do the stopping at the top and bottom of the shaft, with the lever in full running position. Where elevators are held until contact is made by closing the door, some operators have the dangerous practice of holding the lever in the "on" position a few notches and starting the elevator by closing the door. These practices should be prohibited. The stops should be tested out once a day, however, to see that they function properly.

Hoisting Cables

101. Car and counterweight cables should be of steel or iron, and no chains should be used for hoisting.

102. Metal tags should be attached to the cables at the cross-heads and at the counterweight ends. The tags should have stamped on them the date of installation of the cables, diameter, ultimate strength, and material of the cable. It is obviously necessary in replacing



Courtesy, Aetna Life Insurance Co.

FIG. 10. COUNTERWEIGHT CABLES OF DRUMS PASS THROUGH TUBES

Where car and drum counterweights run in the same guides the drum counterweight cables can be run through tubes extending above the car counterweights to prevent wearing of the cables.

worn-out cables to use new cables of material and strength equal to the old ones. Fig. 10 shows metal tubes through which the drum counterweight cables pass, to prevent wearing of cables when car and drum counterweights run in one set of guides.

TABLE OF SAFE LOADS FOR CABLES

Note: In determining the load on the hoisting cables, where no car counterweight is provided, the weight of the car must be added to the live load or capacity.

		FACTOR OF SAFETY							
Dia. of Cable in inches		14	13	12	11	10	9	8	7
		14	13	12	11	10	9	8	7
Cast or Crucible Steel	1/2	1,200	1,285	1,400	1,525	1,680	1,865	2,100	2,400
	5/8	1,400	1,520	1,665	1,815	1,995	2,200	2,500	2,800
	3/4	1,785	1,920	2,085	2,270	2,500	2,780	3,125	3,570
	7/8	2,500	2,690	2,915	3,180	3,500	3,885	4,375	5,000
	1	3,285	3,540	3,835	4,190	4,600	5,110	5,750	6,570
	1 1/8	4,285	4,600	5,000	5,450	6,000	6,660	7,500	8,570
Swedish Iron	1/2	555	600	650	700	780	865	975	1,115
	5/8	670	715	780	850	940	1,040	1,175	1,345
	3/4	855	920	1,000	1,090	1,200	1,330	1,500	1,715
	7/8	1,210	1,305	1,415	1,540	1,700	1,875	2,115	2,415
	1	1,685	1,810	1,965	2,145	2,360	2,620	2,950	3,370
	1 1/8	2,075	2,220	2,415	2,635	2,900	3,220	3,625	4,150

103. The accompanying table shows the safe load of cables and Fig. 11 shows the proper factor of safety for various speeds, from which can be computed the size of cables required for any given elevator.

104. There should not be less than one turn of cable remaining on any winding drum when the car or counterweight has reached the extreme limit of its travel.

105. No car or counterweight cables should be extended or repaired by splicing.

106. No car or counterweight cable should run over a sheave or be wound on a drum whose diameter is less than thirty-eight times the diameter of the cable.

107. Great care should be taken in fastening cable ends into clamps and babbitted sockets. Fig. 12 shows the proper method of turning in the end of cable for one type of fastening. For further information see the A. S. M. E. code or Safe Practices pamphlet No. 26 on "Manila and Wire Rope."

Equalizers

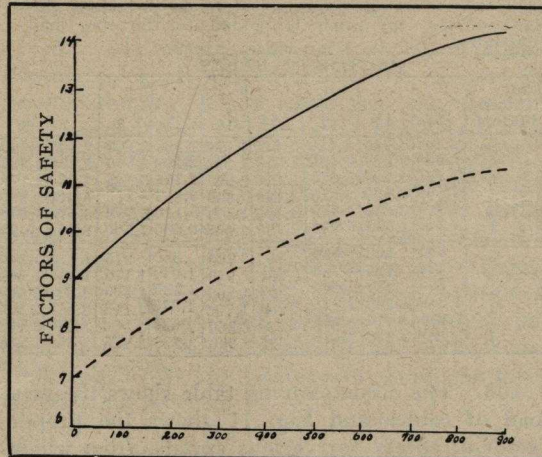
108. Equalizers should be provided at car and counterweight ends of hoisting cables for traction elevators having only two cables.

109. Equalizers should be provided for elevators having winding drums, if the cables wind in grooves on drums scored right and left hand. It is recommended that where practical equalizers should be used if several hoisting cables are attached to a car or a counterweight. It is also recommended that for traction elevators the equalizers consist of compression springs located between the crosshead and the cable anchorage.

Control

110. No passenger elevator, having a speed greater than 100 feet per minute, should be controlled by a hand operated rope or cable.

FACTORS OF SAFETY FOR HOISTING CABLES OF POWER PASSENGER ELEVATORS



Sketched from A. S. M. E. Elevator Code

CAR SPEED IN FEET PER MINUTE

Solid Curve—Elevators With Traction Machines
Dotted Curve—Elevators With Winding Drums and Hydraulic Elevators

111. No elevator whose maximum speed exceeds 150 feet per minute, except a hydraulic elevator, should be controlled by a rope or cable operated by wheel or lever mechanism.

112. All overhead tension weights for hand ropes should be secured by chains attached to the weights and to a suitable anchorage.

113. Groove guards should be provided on all operating sheaves to keep the cable on the sheaves at all times.

114. The controller or operating switch of every electrically controlled elevator should be self-centering and self-locking; that is, it should return to neutral when the hand of the operator is removed.

115. Every electrically controlled elevator should have an emergency switch near the control apparatus so that the operator can cut off the power, if necessary.

116. On mechanically controlled elevators the operation of direction switches or operating valves should not depend solely upon belts, cast or malleable chains.

117. In all types of elevators having hand lever control the levers should be so arranged that the movement of the lever toward the door which the operator usually faces would cause the car to descend and the movement of the lever away from the door would cause the car to ascend.

118. No circuit breaker operated automatically by any fire alarm system should be so

connected as to cut off the power or control from passenger elevator.

119. Push Button elevators are operated by the passenger, who calls the elevator by pushing the button on the enclosure, and after entering the car closes the landing door and car door. He can then take the elevator to any desired floor by pushing the button so marked. The elevator will respond to no other call until the car has reached that floor. All the doors must be closed and locked before the car will start and can be opened only when car again stops at the floor. For further information, reference should be made to the A. S. M. E. code on the automatic push button control type.

120. No wire or other current carrying device should be substituted for the proper fuses or circuit breakers in any elevator circuit.

Signal Systems for Hoistway

121. Passenger cars, according to the nature and importance of their installation should be equipped with proper bells or annunciators together with lights or indicators to show the place from which the call is being made. At the first floor there should be an indicator to show where the elevator is, or which car is to answer the call.

Instructions to Operators

122. These instructions are mostly taken from the A. S. M. E. Elevator Safety Code. A shorter list of twelve instructions covering the points of greatest importance, in form suitable for posting in the elevator car, is given in National Safety Council bulletin number 922.

a. Always open the main switch of an electric elevator or lock the control mechanism of a hydraulic, steam or belted elevator before cleaning or oiling any part of your machine or regulator and before leaving your work.

b. Be sure the control mechanism is in the "Stop" position before closing the main switch.

c. Take a trial inspection trip each morning before carrying any passengers.

d. Report any defects promptly to the person in charge.

e. Do not attempt to make any repairs unless instructed to do so.

f. Carry no passengers or freight while inspections, repairs, or adjustments are in progress and operate the car only in response to directions from the inspector or person in charge. Do not move the car when any one is

in the pit or on the top of the car except as they may direct.

g. See that the "locking device" attachments are in place before a safe or other heavy concentrated load is moved on or off the car platform. Do not attempt to raise the car more than a few inches until the "locking device" has been withdrawn.

h. Do not ride in the elevator nor allow others to ride while a safe or other heavy object in excess of the rated capacity of the elevator is being carried. A load much in excess of capacity should in no case be carried; heavy safes should rather be raised by block and tackle, the elevator being left at the top of the shaft.

i. Hoistway doors and car gates should always be closed and locked before the car is started. The car should be brought to a stop at the landing level before the car gate and the hoistway door are opened.

j. Report at once all accidents of any nature, particularly where injury to persons is involved.

k. Keep car gates, if any, closed while running, and where no car gates are provided keep passengers away from the open edge of the car platform.

l. Limit the number of passengers to the capacity of the car and do not permit crowding.

m. Do not reverse the control while passing a landing on receipt of a stop signal. Continue the trip and respond to the signal on the next trip.

n. Move control mechanism to the "stop" position on approaching the terminal landings. Do not depend on the limit switches in the ordinary operation of the car.

o. If the power goes "off" while the car is in motion, move the control mechanism to the "stop" position and wait for the return of the power.

p. If the car refuses to stop do not attempt to jump off. The car will be stopped by the application of the "safeties" if it attains excessive speed of descend or by the hoistway limit switches at either end of its travel.

q. If the car should stop suddenly, call for the engineer in charge and operate the machine only at his direction.

r. If the car will not start return the control to the "stop" position and look for the following causes:

- (1) Open circuit in main fuses.
- (2) Open circuit in control-circuit fuses.

(3) Controlling device not properly functioning.

(4) Automatic switch contacts, slack-cable switch, limit switches, door contacts, etc., being open.

(5) Lack of lubrication in bearings or thrusts.

(6) That the brake releases properly.

If this inspection shows no defects, and if there are passengers in the car have the car in adjoining section come to a level with the stalled car; transfer passengers through emergency side or top doors, thus removing the weight, and then observe if the car will start with the controller "on."

s. Lock the control mechanism of hydraulic, steam, or belted machine in the "stop" position and open the auxiliary control switch of an electric elevator before allowing any freight to be loaded or unloaded.

t. Be sure to familiarize yourself with the emergency devices, understand their function and know how to operate them.

u. Never leave the car in the ordinary course of operation nor leave the control mechanism unprotected. When going off duty for any reason even for a few minutes be sure that the power is disconnected or that the control mechanism is locked and the hoistway doors closed. When service is suspended for any reason during the ordinary operating hours display a NOT RUNNING sign at each landing.

v. Be sure you are familiar with these rules and keep a copy on your person or in the car at all times.

Qualifications of Operators

123. Care should be taken to select as opera-



Courtesy, Aetna Life Ins. Co.

FIG. 12. METHOD OF TURNING END OF CABLE FOR THIS TYPE OF FASTENING

Great care is necessary in the turning of the ends of cables and the socketing of the cables. Safe Practices pamphlet 26 on "Manila and Wire Rope" gives more details on this subject.

tors persons who are not under eighteen years of age, can understand and talk English, and are thoroughly reliable persons.

ACKNOWLEDGMENT

This Safe Practices pamphlet was prepared by J. J. Lamb, Safety Engineer, National Safety Council. The Council acknowledges the use of valuable information from the elevator code

of the American Society of Mechanical Engineers; the courtesy of members and others who kindly furnished pictures for illustrations; the helpful criticisms and suggestions of engineers of various elevator manufacturers; the assistance of the department engineers of several states, and the valuable service rendered by the Conference Committee of seventy safety engineers.

Rules for Elevator Operators

You cannot run an elevator properly and safely and carry on a conversation or do something else at the same time.

1. Be sure the gates or doors are closed and latched and that everybody and everything is in a safe position before you start the elevator.

Better a delay than an accident

- | | |
|---|---|
| <ol style="list-style-type: none">2. Always remember the safety capacity of your elevator and never allow it to be overloaded.3. Bring the elevator to a full stop before you attempt to reverse its direction. Start the car slowly.4. Be sure to center (place in neutral position) your hand rope, lever, wheel, or switch controller; and wait until the car has come to a full stop before you open the doors or gates.5. Do not try to show off by speeding your elevator. Watch the speed carefully when going down as a heavy load may increase the speed.6. Learn the emergency call (which is one long and three short rings, thus: — — —) and get to the floor from which the call came as quickly as possible.7. If the elevator does not operate properly for any reason, do not attempt to run it. Notify your superior at once. | <ol style="list-style-type: none">8. If the safety device should operate and stop the elevator, do not attempt to start the car. Send for your superior immediately. If the elevator should stop between floors, keep cool and do not allow anyone to leave the car.9. Do not permit unauthorized persons to operate the elevator.10. Never leave the elevator unattended unless the car is empty and the doors or gates are closed and latched.11. Be careful to stop the elevator with the car floor level with the landing floor. If you have failed to do so give warning by saying, "step up, please," or "step down, please,"—as the case may be. Never attempt to correct a bad stop by moving car after the doors or gates are opened.12. Fooling, scuffling, or horse play are prohibited in elevators. Require passengers to face the doors or gates, and do not allow them to enter the car until any who desire to leave have gotten off. |
|---|---|

Always remember that your life and the lives of others are dependent upon your alertness, caution, and good judgment